Removable Thin Films used for the Abatement & Mitigation of Hazardous Particulates

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Introduction

- Removable thin films are designed to trap and fix particulates in the film's matrix by adhesion.
  - Thin films can be applied to an existing contaminated area to fix and capture the particulates for removal.
  - After sufficient cure time, it can be removed as one continuos entity.
  - The removable thin films can be applied to almost any surface type with a high success rate of removal.

Background

- This technique was tested during the Decontamination and Decommissioning (D&D) of the Tokamak Fusion Test Reactor (TFTR).
  - The removable thin films were applied to areas that were contaminated with lead oxide.
  - This technique had a high success rate of removal of lead oxide particulates.

Background

- A significant industrial hygiene concern during D&D of TFTR was the oxidation of the lead bricks' surfaces.
- These bricks were utilized for radiation shielding.

Hazards of Lead

- Lead differs from many metals, in that it serves no biological function.
- Lead is readily absorb from the lung and is the predominate route of exposure in occupational settings.
- The OSHA PEL (Permissible Exposure Limit) is $30 \mu g / m^3$

Hazards of Lead

- Approximately 35% to 40%, of the total lead inhaled, actually enters the blood.
- The OSHA biological-monitoring standard for blood lead is a maximum concentration of 50µg/100ml whole blood.
  - Blood sampling analysis is mandatory every 6 months for workers exposed above the PEL for more than 30 days per year.

Hazards of Lead

- Repeated exposures can cause a gradual accumulation of lead, particularly in the bones.
- Bone has the highest affinity for lead.
  - Biophysically lead resembles calcium, which may explain its high affinity for bone.
- Symptoms of chronic exposure can include anxiety, weakness, headaches, tremors, excessive tiredness, and other indicators of nervous damage.

Lead Removal During D&D

- From1999 to 2001 approximately 250,000 pounds of lead was safely removed.
  - Typically, the lead was in the form of bricks, each weighing approximately 27 pounds.
- After years of use, many of the bricks were observed to be coated with a layer of white powder.
  - Analysis of this powder revealed Lead oxide.

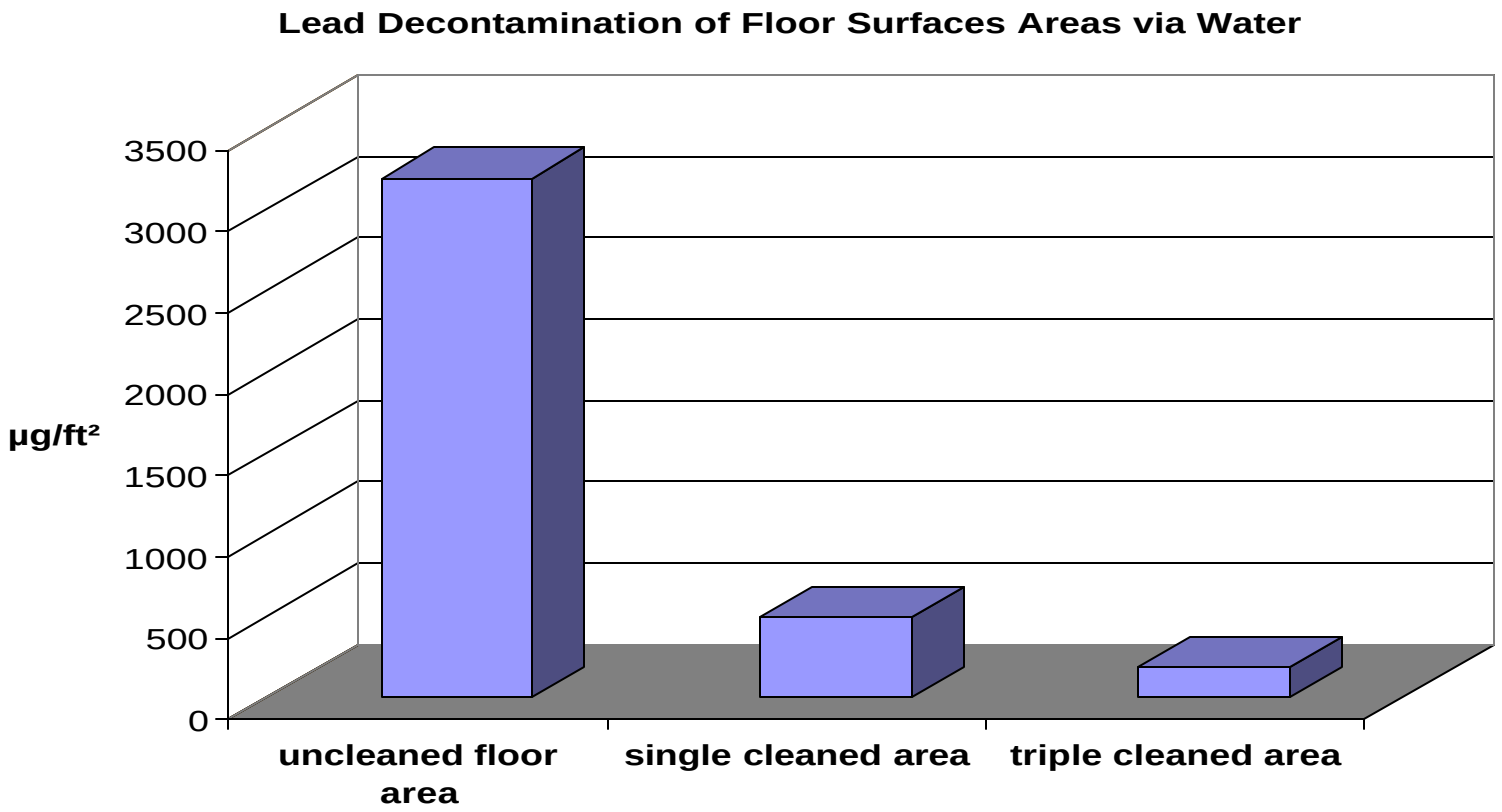
Lead Removal During D&D

- During the removal of the bricks, this powder had a tendency to become airborne and eventually resettled on other surfaces throughout the work area.
- This re-deposition was a serious concern because of the high number of workers performing collateral tasks associated with TFTR D&D.

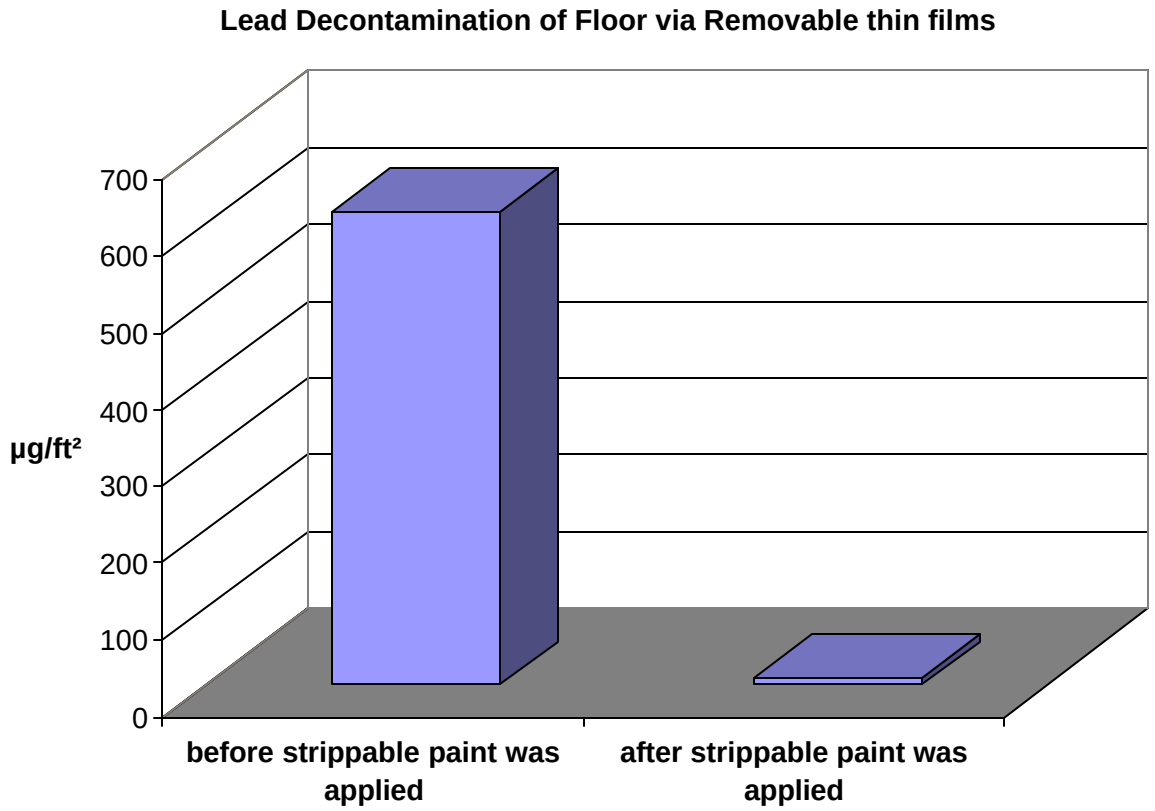
Mitigation of Lead

- To mitigate this problem, different methods were tested.
  - Water
  - A High Efficiency Particulate Air Filter (HEPA) vacuum
  - Removable Thin Films
  - Acetic Acid

Mitigation of Lead



Mitigation of Lead



Results

- After an extensive literature search, it was concluded that this was the first time removable thin films were used for mitigation of lead dust.
- After the various techniques were tested, it was determined that the use of removable thin films provided the most effective means of decontamination.

Results

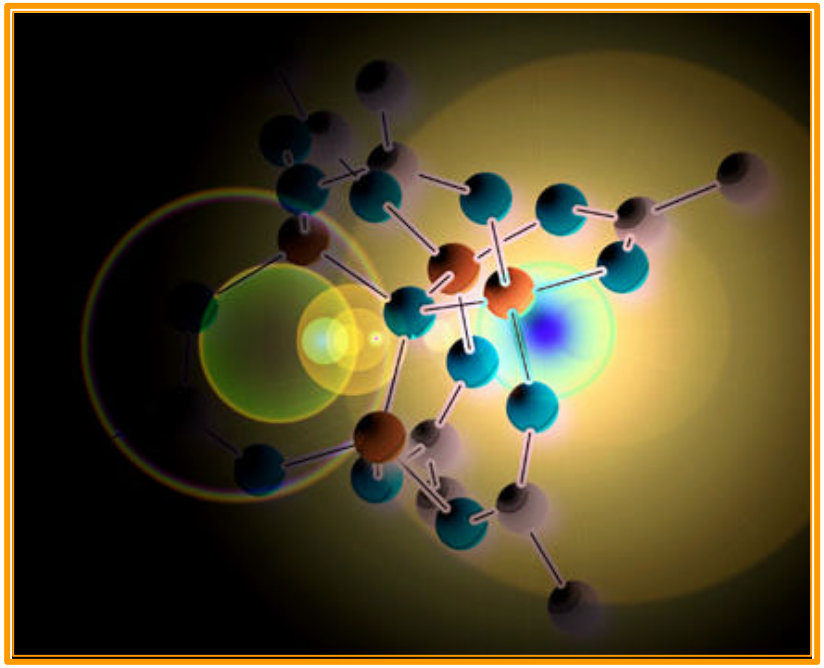
- The removable thin films were both highly effective in abating the lead dust and cost effective, due to the single application process.

Motivation

- Due to the success of the removable thin films for lead dust contamination, this process may be useful in the decontamination of other hazardous particulates.
- These particulates include beryllium, which is widely used throughout DOE and commercial industry.

Beryllium

- Elemental Be
  - lightest of all chemically stable solids
  - lighter then aluminum and 40% more rigid then steel



Beryllium

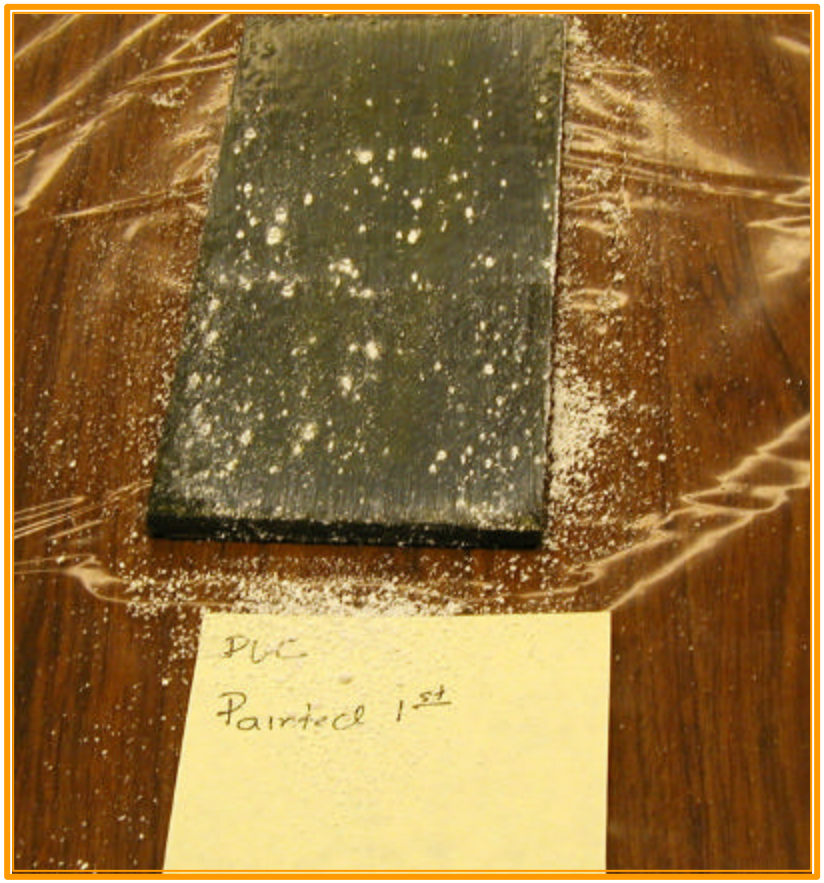
- Used within nuclear facilities, computer parts, high performance aircraft brakes.
- BeO is ideal for transistor mountings and semiconductor packages.

Hazards of Beryllium

- Inhalation is the primary route of exposure
- Non-cancerous endpoints
  - Be sensitization
  - Chronic Beryllium Disease
  - Acute Beryllium Disease
- Carcinogenic endpoints
  - lung cancer
- 1993 IARC classified Be as a Group 1 Carcinogen

Phase I

- Two proof of principle tests were conducted.
- First, the removable thin films process was applied to various surfaces that were contaminated with a luminescent dust.



Phase I

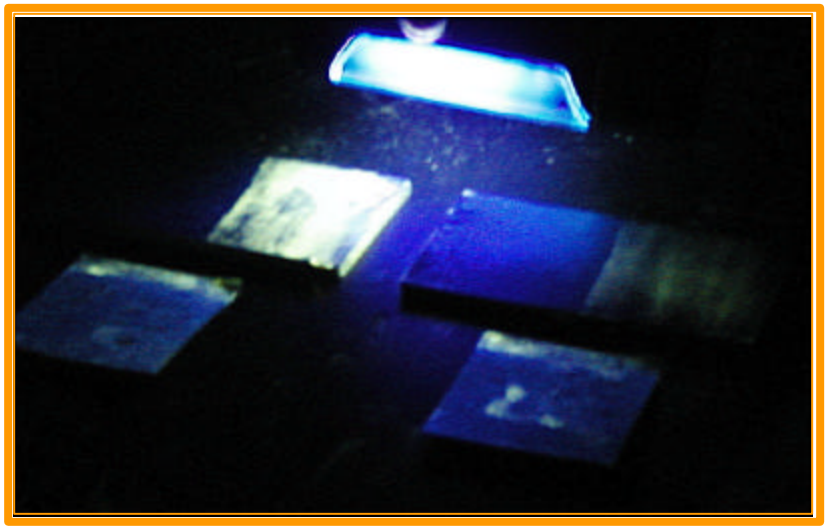
- Some of the samples were first coated with the removable thin films, next the dust was applied, then the samples were coated with another layer of the removable thin films.

Phase I

- Other samples were first coated with the dust; then the removable thin films were applied.
- After the thin films dried, they were removed.
- The removable thin films peel off as one entity.

Phase I

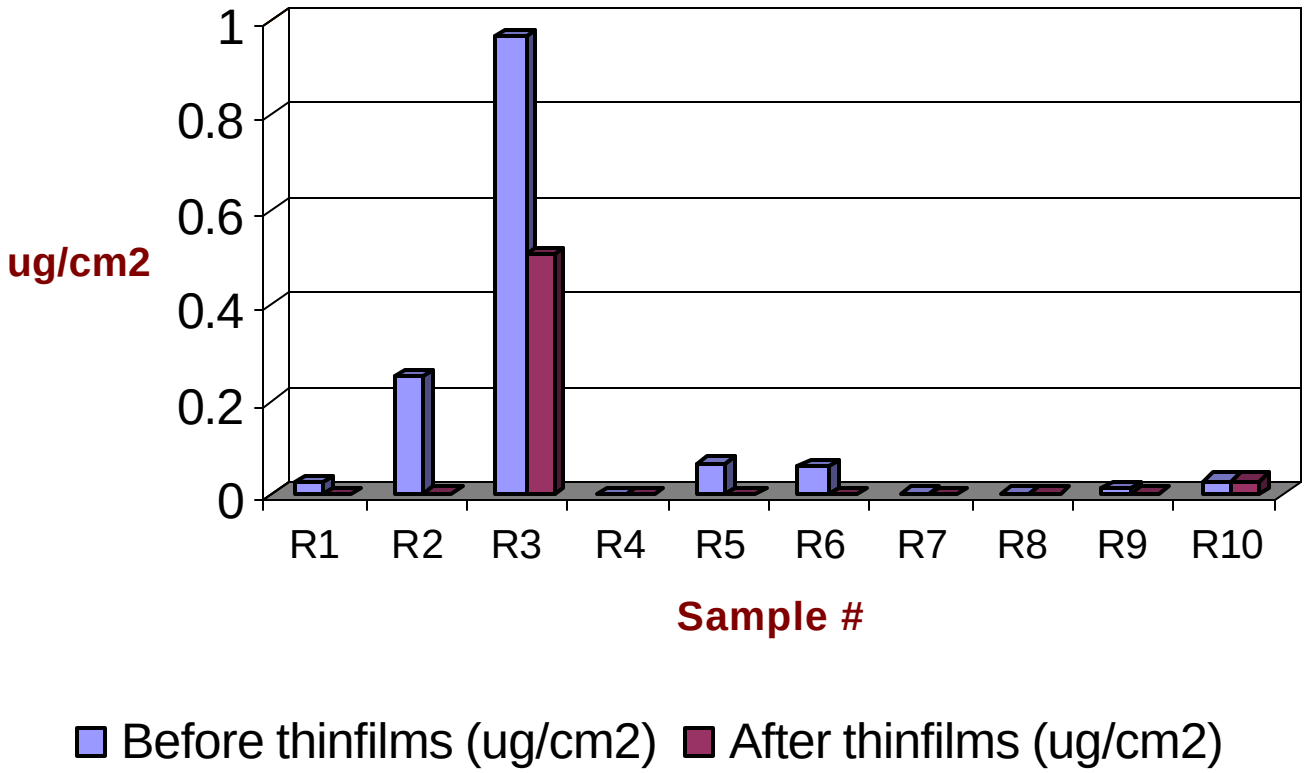
- It was found that the samples coated with the removable thin films before the dust was applied, mitigated the contaminate more efficiently.



Phase II

- The second proof of principle test was conducted at a beryllium facility located at Los Alamos National Laboratory.
- The same application method that was used for the luminescent dust, was used on various surfaces.
- These surfaces include: floors, walls, ventilation ductwork, light fixtures, and milling machines.

Phase II


1
0.8
0.6
0.4
0.2
0
ug/cm2
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
Sample #
Before thinfilms (ug/cm2)
After thinfilms (ug/cm2)

Phase II

- This test resulted in a two order of magnitude reduction of beryllium contamination, after one application.
- The use of thin films for the removal of hazardous particulates provides a highly efficient and cost effective technique.

Phase III

- Test removable thin films as a preventive control for beryllium particulates.
- Increase the efficiency of film's adhesion process.
- Improve the removal process of the thin films after they have cured.
- More field testing of the removable thin film technique
- Secure more funds for testing